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The study of industrial town refinery sludge effects on *Festuca arundinacea* Schreb growth and phytoremediation capacity

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Abstract

This experiment designed to study the effects of Mashhad industrial town refinery sludge via its mixture with cultured medium in randomly 3 concentrations, 10%,15% , 20% weight on growth and physiological specifications and phytoremediation capacity of Nickle and Lead by lawn *Festuca arundincea*. The results showed that using sludge did not have significant effect on morphological characteristics such as fresh weight of root , aerial organs, leaf width, root length and the ratio of wet weight over aerial organs.Though, sludge application in lawn caused height reduction and increased dry weight ofroot and aerial organs. In thatthe amount of chlorophyll b and carotenoids changed significantly and stomata conductivity demonstrated drastic reduction with increasing sludge to 20 wt% .*Festuca arundinaceae* species showed ability of Ni and Pi accumulation in aerial organs and roots. The amount of accumulation was higher in root. Given that growth ability of *Festuca arundinaceae*in culture medium in combination with Mashhad industrial district refinery sludge showed the capacity of remediation of heavy metals Ni and Pi and reducing environmental riskswhich proved this sludge capacity to reduce environmental risks .Thus this species is introduced as phytoremediation plant in landscaping.

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Introduction

The sludge of refinery is an organic material, produced in biological wastewater treatment process without any cost and in certain periods of time. Some of the sludge, which is redundant, must be transferred to the sludge drying beds and to be removed from refinement process (Karimpor *et al.*, 2010). In most refineries the sewage and sludge have organic compounds that could help soil structure modification. So far, a major strategic concern is the excessive production of sludge in refinery whose collection from sludge medium of drying machines beds and storing in refinery area are often problematic ,for they must be regularly emptied and removed from the area that impose heavy costs on refinery management finance. (Bostani and Ronaghi, 2011; Shabanian and Brojerdi, 2004). In addition to heavy costs, the sludge disposal and its safe burial both are cases to engage refineries managers' minds. Commonly, various methods are used to safely dispose and bury sludge which brings out its own disadvantages ,for basically sludge removal is not economic and other cost effective methods usually ignore nutritional potential of sludge(Mir-Hoseini *et al.*, 2007; Heidy, 2007). Methods such as burning have consequences of carrying pollutant and heavy metal to the depth of soil and underground water which cause damages to environment (Shabnian Brojerdi, 2004).

Mashhad industrial town refinery (Kalat) operates in late 2006.Along its operation, the active sludge which is a redundant material, made from wastewater produced during the process of manufacturing procedures .The produced sludge in refinery, generally have organic substances and elements, which in most cases are essential and beneficial for plants growth and development. That is why the, application effects of refinery sludge instead of other organic fertilizer in soil quality were investigated in several studied (Jalai *et al.*, 2010; Shabanian brojerdi, 2005; Antonius and Sneder, 2007; Jamil *et al.*, 2004). Admitting the availability and production of active refinery sludgeas an integral part of biological refinery works, in the world, several standards have been established to re-use the produced sludge. Sludge application ,at least, as the organic fertilizer is recommended in the vicinity of refinery fields. (Melali *et al.*, 2009; Movahedian *et al.*, 2002).

As is the case in sustainable development, the smallest optimum opportunity should be timely counted to not leave any useless or hazardous material either unexamined or unidentified to release to immediate environment as waste. So we can consider sludge of Mashhad industrial town as a source of organic fertilizer that has suitable elements for plant growth. Taken into account all environmental consideration, essentially this sludge should be studied analytically. In preliminary studies, it has been found that industrial refinery sludge has various pollutant including mineral biological and heavy metals, soreusing it asan alternative to manure fertilizer and other organic fertilizers needs more analyses and focused management to avoid environmental pollution (Zamani-bab¸ 2010; Karami *et al.*¸ 2010). Different research has demonstrated that heavy metal deposit sediments in different plant tissues. To determine the location of heavy metals accumulation in different lawn tissues, it will be crucial to adopt a right strategy in the quality of treatment with lawn medium during growth period, maintenance and trimming (Taghizadeh *et al.*¸ 2011).

Therefore in using sludge to fertilize agricultural soil, it is essential to first take caution to be aware of sludge content. Today, thermal chemical methods, biological refinery, sludge composting and other methods reduced significantly sludge sanitary risks. Albeit, carrying out this method is generally costly.

Other suitable and scientific methods to recognize drawbacks of such fertilizers in terms of soil and plants are application of sludge as fertilizers in plants culture medium and qualitative and quantitative assessment of yield of cultured plants in the soil (Opestien *et al.*, 1976; Karel *et al.*, 2002; Gopta *et al.*, 2004). Meanwhile, Siew *et al.* (2002) investigated four elements'absorptionPb, Zn, Ni, Ki, at few survival plant species in metal melting factories in China. He studied absorption characteristicsin these plants. The results showed that metal absorption varies in terms of the species, tissues and metal type. Four species for Cadmium absorption and seven for absorption of Lead in normal absorption concentrations were chosen. Specially,*Abutilon theophrasti*Medi, had the highest absorption ability compared with other four metals. Generally, Parks have capacity to refine 80% of air pollution. Trees, bushes and shrubs control air pollution up to 70%.

Even leafless trees in winter are able totodo 60% of their efficiency to refine air pollution and they can reduce sound pollution to 12 decibel. But among them lawn is themost important, because lawn has wide areaboth in aerial part and in soil, for which it is considered as the most important phytoremediation plant (Abedikopaii, 2001). It is reported that lawn grown at 15-0cm soil depth, had the highest intensity, whichimplies that there is also the region with the highest concentration of lead.

This study was to adopt methods to use sludge of industrial towns refineries of Mashhad and other industrial districts. Lawns cover the major part of landscape of which regular trimming enhances the chances of reducing soil heavy metals (Taghizadeh, 2011), so in this research the potentials of *Festuca arundinacea* in remediation of heavy metals were investigated.

Materials and methods

Plant material and soil

The seeds of *Festuca arundinacea* cultured in plastic pots with diameter 210mm and 45cm height and at greenhouse condition after surface sterilization was carried out. Cultural medium included control sample (natural soil), soil and dry sludge at 10, 15 and 20 weight%. Thus, for example at 10 wt%, 10gr sludge was added to 90gr soil and then used. Used soil at this experiment was loam without salinitylimitation and (or) other agricultural limitations. For measuring soil and sludge elements, 25gr wasweighted and 10gr dry sludge added to soil and was used. To measure soil and sludge elements, 25gr weighted and poured in 250ml erlenmayer and 50 ml extractor solution, whose pH set at 7.3.It was added and the container was closed and shaken with rotary shaker GFL model at 145 rounds/min and cleared with filter paper Whiteman 42.

Then, atomic absorption spectrometry connected to a graphite furnace, turned on and installed special light for each element.Afterwards, setting machine element concentrations was read. If elementconcentrations in extract was higher than standard device, we can dilute samples with D.T.P.A solution at essential amount. Soil texture with hydrometer (Gay and Bader, 1986), soil pH with pH meter (Makline, 1982) and electrical conductivity in saturation extract were measured by conductivity meter device.

Morphological features

This research analyzed characteristics were inspected in two parts. The first part associated with sludge effects and its different levels on lawn growth. In this part morphological attributes such as aerial organs and roots length, aerial organs and roots dry mater, fresh weight of aerial and root organs, the ratio of roots fresh and dry weights to aerial organs, lawn leaf width and some of physiological characteristics, including total amount of chlorophyll, chlorophyll a, b, carotenoid amount, ion leakage, stomatal conductivity rate and leaf area indexes were measured, so different levels of sludge on lawn growth investigatedto find what level of sludge may produce the best growth quality.

Lawn canopy height calculated every 14 days before trimming. To do it, the ruler was tangent to both soil surface and a paper sheet, which has a hole in its center and simply moves in ruler with ruler movement, which isputin 3 points in each experimental unit and the heightwas calculated. Fresh weight and dry weight of roots were measured every two weeks. Trimming done by scissors at approximately 4cm height. It was then weighed and put in paper pockets and transferred to oven at 72 C for 48hours and finally dry weight was measured. Roots were removed from soil, washedanddried completely.Then fresh and dry weight was calculated.

Physiological Features

The Amount of chlorophyll and carotenoid

Chlorophyll and carotenoid measurement based on Tatari *et al.*, (2013) method. Leaf pigments were extracted with acetone 80% and read at 663nm, 645nm and 470nm wave length with spectrophotometer. The amount of chlorophyll and carotenoid were measured using following formula,

Chlorophyll a= 12.25A663 – 2.79A645

Chlorophyl b= 21.50A665 – 5.1A663

Chlorophyll a+b= 7.15A663+ 18.71A645

Carotenoid=[1000A470-1.82(chlorophyll a) – 85/02(chlorophyll b)]/198.

Leaves relative water content

Leaves relative water content (RWC) in completely developed leaves calculatedafter initial leaf weighing.While they had been immersed in distilled water for 24 hours .Then they were dried at 75 C and calculated by the following equation (Smart and Bingham, 1974):

RWC= ((fresh weight – dry weight)(turgor weight – dry weight))×100.

Leaves ion leakage

The amount of ion leakage was calculated by dividing initial electrical conductivity on electrical conductivity of dead cells (Ci/Cmax) (Hu *et al.*, 2010).

Leaf area index

For determining leaf area by leaf area measuring Acupar (Delta T), leaf area index was inspected.

Stomatal conductivity

Stomatal conductivity measurement performed by using photosynthesis measurement tool Wales incorporation Germany, HCM-1000, after it was irrigated in saturation state (Also located within the leaf container device) onfour-week bushes.

Heavy metal measurement

The amount of heavy metalssuch as Lead and Nickel in different organslike leaves and rootswere measured four months after growth. Also, the amount of these heavy metalswere measured and compared in soil before and after lawn growth.

To measure the amount of heavy metals in plant tissues, we used atomic absorption spectrometry, equipped with graphic furnace with precision of 1 ppb. Plant organs including leaves and roots primarily washed with distilled water and then dried for 48 hours in oven at 80 C. Afterwards, plant samples were crushed and extracted by H2O2 and Nitric acid.Finally, the amount of heavy metals-Lead and Nickel -were measured. To measure the amount of heavy metals, atomic absorption spectrometry of Science and Technology Park, Khorasan Razavi, was used.

Statistical calculations

This experiment was done in completely random designsby 4 repetitions. Data arrangement performed using Excel Software and required analyses performed on SPSS software 19. Means comparison was done by using Duncan test at 5% probability.

Results and discussions

Physical characteristics of applied soil and sludge in table 1 and soil texture in table 2 are given. The amount of Nickel and Lead, which used in this experiment, found lower than global standardallowance. The amount of Lead and Nickel in used sludge was higher than soil.

The amount of Nickel in Mashhad industrial town refinery was higher than different organizations' standards.So we could say,it was within the permissible limits of metals in soil. The amount of Lead despite inexperimental sludge sample was twice higher than soil, but it was within the Standard range (Table 1, 2).

Table 1, 2. The physical and chemical characteristics of sludge and soil used in this experiment.

	Pb (mg/kg)	Ni (mg/kg)	Fe (mg/kg)	CO3H (mg/kg)	pH	Clay (%)	Silt (%)	Sand (%)	EC (dS/m)
Soil	42.8	25.4	3.5	953	6.4	30.5	43	26.5	6.6
Sludge	81.5	62.7	4.3	911	7.2	-	-	-	9.1

The results of variance analyses showed that the treatment using different sludge concentrations of industrial refinery have significant effects in probability level 1 and 5%on most morphological, physiological attributes and phytoremediation capacity of lawn *Festuca arundinacea* (Table 3).

Morphological features

Analysis of variance showed that the treatment using different levels of sludge did not have significant effect on morphological characteristics including root length, root fresh weight and aerial organ, the ratio of fresh weight on aerial organ and leaf width (Table 3).

Due to using sludge, the height of studied lawn sample showed significant reduction at 5 percent probability (Table 3). *Festuca arundinacea*lawn height in control sample (10.73cm) was the highest for using 20 weight% the sludge of industrial town refinery (9.1cm) which showed significant reduction (Table 1). Industrial refineries and other wastewater sludge characteristics varies in terms of environmental pollutants like, high salinity, acidic condition and ..., which to leads hazardous conditions for plant growth.As a result it causes growth and developmental reduction which may even kill plants. Thisadverse impact depends upon type of plant species and its resistance along physical and chemical attributes of sludge and wastewater. Soroush *et al.*, (2008) reported that irrigation with refined wastewater from Shahin Shahr wastewater refinery caused significant augmentationat 1% probability in Japonica lawn height.

Table 3. Analysis variance of morphological characters and Lead and Nickel concentrations in root andareal organs *Festucaarundinacea* under sludge treatment of Mashhad refinery.

		Mean square												
Source	df	Ni-R	Ni-A	Pb-R	Pb-A	Height	Length-R	DW-R	DW-A	FW-R	FW-A	R/A(DW)	R/A(FW)	LW
Treat	3	0.119**	0.080**	7.45**	1.084**	4.829*	12.937 ns	56.83**	49.08*	1.924 ns	50.88 ns	0.018**	0.001 ns	0.009 ns
Error	12	0.003	0.002	0.138	0.091	0.701	24.45	5.14	10.99	1.342	34.01	0.003	0.001	0.006
CV		23.2	18	9.1	14.5	10.78	20.94	17.8	15.32	15	18.5	11.1	8.2	12.7

**, * and Ns, showed significant effects at 1, 5 percent and insignificant, respectively.(Ni-R= Nickel of roots, Ni-A= Nickel of areal parts, Pb-R= roots Lead, DW-R= dry weight of root, DW-A= dry weight of areal parts, Fw-A= fresh weight of areal part, R/A(DW)= the ratio of root dry weight on aerial part, R/A(FW)= root fresh weight on aerial part, LW= Leaf width).

The amount of dry weight root at 1% probability and aerial part of lawn *Festucaarundinacea* at 5% probability affected by so-called sludge, showed significant differences in terms of controlled sample. The highest amount of root dry weight (18.475 per pot) gained at 20 wt% sludge and the lowest amount of root dry weight is related tocontrolled one. The highest amount of aerial organ dry weight obtained in treatment of 20 weight% withthe treatments of using 10% and 15% sludge had the highest aerial organ dry weight (Table 5). Given that sludge sample analyses and high amount of nickel, Lead and iron (Table 1), this augmentation in dry weight in various lawn organs is not explainable. The ratio of root dry weight over aerial organ wassignificant at 1%, too (Table 3). Different studies reported conflicting results in terms of changes in dry weight of various organs in remediating plant. Adavi (2010) investigatedoil hydrocarbon phytoremediation by different cultivars of lawn Bermodagrass and reported that according to destructive effects of oil hydrocarbon on plants, adding oil refinery sludge into soil results in reducing aerial organ dry weight in lawn. Besides, oil refinery sludge addition to 20% leads to augmentation in root dry weight .Higher levels of sludge results in reduction in dry weight of root. It can be concluded that the amount of sludge and wastewater affect dry weight changes of plant organs. Soroush*et al.*, (2008) reported that in response to irrigation with wastewater of industrial refinery the dry weight of different Japonica lawn organs increased.

Table 4. Analysis of variance physiological characters of *Festucaarundinacea* under sludge treatment.

Source	df	Mean square							
		LAI	Chlo-T	Chlo-a	Chlo-b	Cartenoid	RWC	SC	EL
Treat	3	0.037 ns	0.131ns	0.060 ns	0.028*	0.026*	8.16 ns	4317.5*	16.41*
Error	12	0.036	0.102	0.107	0.006	0.008	14.2	381.2	7.11
CV		25.4	21.33	19.7	22.9	12.46	21.64	14.8	16

**, * and Ns, showed significant effects at 1, 5 percent and insignificant, respectively.(LAI= leaf area index, Chlo-T= totall chlorophyll, Chlo-a= chlorophyll a, Chlo-b= chlorophyll b, RWC= relative water content of leaves, SC= stomatal conductivity of leaf, EL= ion leakage).

Physiological Features

Based on results from variance analysis of physiological characteristics, leaf area index, the amount of total chlorophyll, chlorophyll a and leaves relative water content (RWC) did not show significant changes due to sludge application (Table 4). Meanwhile, due to high salinity effects of sludge, leaves relative water content was expected to reducebut no changes was observed.

The amount of carotenoid showed significant changes at 5 percent probability level during experiment (Table 4). The highest amount of carotenoid (0.487 mg/gr) achieved in treatment of 20 weight% industrial refinery sludge.The amount of carotenoid reduced by reducing sludge. Due to refinery used sludge, the amount of chlorophyll b reduced and the highest amount of chlorophyll b were seen at controlled sample and the lowest amount of it obtained in treatment using 20 weight% (0.398 mg/gr fresh weight) (Table 5). Tatari *et al.* (2013) reported 30% reduction in total chlorophyll and b and photosynthesis capacity in *Poapratensis*may be due to drought stress. In present study, high electrical conductivity of sludge and water deficiency observed in plants could be reasons for chlorophyll reduction. 20% water requirementreduction of plants caused damageson chloroplast envelope and finally resultedin plant death (Kieser, 1987; Fou hang, 2001). However, it seems that, in this experiment significant reduction in chlorophyll b results from essential factors reduction and theirdestroyed structure. It meant that, chlorophyll catabolismincreased in drought stress. Hang *et al.*, (1998) reported that irrigation of *Festuca arundinaceae* with wastewater had significant and negative effects on chlorophyll concentration.

The amount of stomatal conductivity at 5% probability resulted in significant changes (Table 4). Application of high concentrations of sludge caused stomatal conductivity reduction in leaves *Festucaarundinaceae*, as the maximum amount of stomatal conductivity (268 µmol/m2/s) achieved in controlled treatment and the lowest amount associated with 20 weight% treatment (194.5 µmol/m2/s) (Table 5). Stomatal conductivity reduction could result from various reasons, various stresses,specially salinity and drought caused stomata closure, reduction in stomatal conductivity and as a result photosynthesis reduced. Mohsenzadeh *et al.*, (2003) reported reduction in stomatal conductivity and photosynthesis rate in wheat that irrigated with wastewater and under stress condition.

Ion leakage of lawn leaves of *Festuca qrundinacea*due to using refinery sludge shows significant change at 5% probability (Table 4). The lowest amount of ion leakage observed in controlled sample (39.5%) with 5 wt% treatment and two levels of sludge 15% and 15 weight% .In this respect, characters previously set in one statistical level did not show significant differences (Table 5).

Table 5. Mean comparison of physiological and morphological traits of *Festuca arundinacea*treated by sludge of industrial town refinery of Mashhad.

	Ni-R(mg/kg)	Ni-A(mg/kg)	Pb-R(mg/kg)	Pb-A(mg/kg)	Height (Cm)	DW-R(g/gol)	DW-A(g/gol)	R/A(DW)	Chlo-b(mg/gfm)	Cartenoid (mg/gfm)	SC(µm.m².s)	LE (%)
0	0.245c	0.197b	8.225d	6.55c	10.73a	9.925c	15.075c	0.655b	0.583a	0.308b	268a	39.5b
%10	0.315c	0.262b	9.1c	7.11b	11a	13.275bc	17.85bc	0.746a	0.568ab	0.408ab	252ab	38b
%15	0.455b	0.442a	10.52b	7.35ab	9.84ab	16.6ab	20.675ab	0.793a	0.501b	0.473a	220.25b	44.6a
%20	0.635a	0.492a	11.25a	7.8a	9.1b	18.475a	23.175a	0.802a	0.398b	0.487a	194.5b	46a

In each column, Figures with a joint letter do not have statistically significant differences.(Ni-R= Nickel of roots, Ni-A= Nickel of areal parts, Pb-R= roots Lead, DW-R= dry weight of root, DW-A= dry weight of areal parts, R/A(DW)= the ratio of root dry weight on aerial part, Chlo-b= chlorophyll b, SC= stomatal conductivity of leaf, EL= ion leakage).

As most stresses are associated with oxidative stress, when it arises, toxic groups production, storing and destructive free oxygen were increased. Consequently, electrolyte leakage during stress increased (Hepler, 2004). In this research by using sludge, the amount of ion leakage increased; given the high amount of EC sludge for lawn exposed to salinity stress and resultedion leakage. The existenceof unsaturated fatty acid proxidationin membrane phospholipids involved in increase of electrolyte leakage in membrane (Inzo and Montagu, 1995).

Fereyra *et al.* (2001) conducted experiments with different ratio of sludge with mixture of cultivation of Fabaceae and grass plants. After four cycles of cultivation plots treated with sewage sludge, in comparison with plots that receivedjust chemical fertilizer, Theyshowed better physical and chemical properties, such as the amount of total phosphorus, absorbable phosphorus at plant CEC, water maintaining capacity in soil. Organic carbon and sewage sludge in comparison with chemical fertilizer showed augmentation. In India more than 150 fields with extent of 12000 hectares irrigated with at least 500 million cubic meter sewage water in 1986. In this country irrigation with sewage has rapidly grown since 1985 and according to available statistics, today about 3 million hectares of agricultural fields, which located in vicinity of big and small citieswhich are under cultivation of rice, wheat and maize, irrigated with sewage wastewater (Shend *et al.*, 1985).

Nickel phytoremediation

Based on variance analyses, the amount of Nickel in leaf and root of *Festuca arundinacea*,showed significant differences at 1% probability due to application of industrial refinery sludge with respect to controlled (Table 3).The highest amount of Nickel gained in roots (0.635mg/kg), 10 weight% (315 mg/kg) and controlled sample (0.245 mg/kg). The amount of nickel at Arial part of lawn like root, showed augmentation with increase sludge percentage and in 20% treatment the highest amount of nickel (0.492 mg/kg) achieved in leaf with control sample and 10% and 15% had significant differences (Table 5). Sorush*et al.* (2008) in research on heavy metals absorption by Japanian lawn cultivars (Zotshia grass) after irrigation with different wastewater treatment in different soil texture ,concluded that soil texture did not affect element absorption in this lawn cultivar, but using wastewater for irrigation caused increase in absorption heavy metals Nickel, Lead, Cadmium and Cobalt, but irrigation with wastewater results in augmented absorption of heavy metals nickel, Lead, Cadmium and Cobalt, but irrigation with wastewater did not affectIron and Zinc absorption. According to El Soraii *et al.* (2009), *Conocarpuslancifolius* tree, is able to accumulate high levels of Cr, V, Ni in its own root. This tree is also able to accumulate Al, Ca and Fe in high amounts in allorgans. To analyse absorption ability of heavy metals by some tree species, an experiment in completely random designs with 3 repetitionswas done in the vicinity of Lead and Zinc manufactures in Zanjan. Tree species of in question, samples prepared from their shoot, leaf and soil and Pb, Zn, Cd and Ni with ICP machine were measured.Results showed that among analysed species, Poplar and Acacia in terms of high absorption of Pb, Zn and Ni in their shoots and poplar tree for reasons of high absorption of lead, zinc and cadmium in theirleaves, could be suitable trees to cultivate in polluted areas of landscape (Moradi, 2009).

Lead Phytoremediation

Due to the application of different amounts of industrial refinery sludge, variance analyses showed that the amount of lead in root and aerial part of lawn *Festuca arundinacea*, demonstrated significant changes at 1% probability (Table 3). The highest amount of lead in 20 weight% treatment (11.25 mg/kg) achieved and the lowest amount showed in controlled sample. The highest amount of lead obtained in aerial part of studied lawn in two treatments 20% (7.8 mg/kg) and 15% (7.35 mg/kg) weight and significant differences between two weren't not observed. The lowest amount of lead was in aerial part of lawn *Festuca arundinacea* (6.55 mg/kg) in controlled sample (Table 5). Taghi-zadeh (2009) compared and analyzed the ability of lead absorption at different concentrations with three lawn genus ray grass, Kentuckyblue grass and Bermuda grass and reported that with increasing the amount of lead concentration in soil, generally the amount of lead accumulation in aerial organ and roots also increased which this absorption in aerial organs of ryegrass was the lowest and in Kentucky grass was the highest. Also, the amount of lead accumulationin lawn root in Bermuda grass was the lowest and in rye grass the highest amount of lead absorption and accumulation occurred. Besalat-pour *et al.* (2010) during a study, which conducted on different species, finally suggested *Agropyrongaertn* and *Festuca arundinacea* for final investigation of oil wastewater and heavy metal phytoremediation. In Graska's (2011) experiment clearing polluted soil with heavy metal lead, nickel and zinc at pot condition and in environment were used. In that study, the average lead absorption in wild amaranthus plant was higher than other plants.

Conclusion

Results showed that industrial refinery sludge application did not have effects on most growth characteristics of *Festuca arundinacea*,yet caused height reduction and significant increase in aerial and underground organs' dry weight. *Festuca arundinacea* species in term of remediation ability of lead and nickel from soil had high capacity and the amount of accumulation of such elementsin underground organs was higher than aerial organs. As a result, we can introduce *Festuca arundinacea* species as suitable remediating species for pollutantslike lead and nickel grounds. To remediate a polluted area with various contaminants (through phytoremediation), plants should be chosen so that they have growth and adoptability with pollutedareas and have possibility of germination, growth, extension and development of roots (Adam and Duncan, 2002). Although reports about ornamental plant phytoremediation in polluted grounds with Environmental pollutants, including heavy metals are limited but recognition of resistant species and phytoremediation and introducing them is important in gardening, landscape extension and improvement of land.

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